BSI Environmental Inc.

Mr. Kevin Adler
Remedial Project Manager
Superfund Division
USEPA
77 West Jackson
SR – 6J
Chicago, Illinois 60604

July 16, 2003

Dear Mr. Adler:

Attached please find a document, which outlines the conclusions of the Waukegan Manufactured Gas Plant Environmental Remediation Study which was performed by BSI Environmental Inc. (BSI) on behalf of General Motors, North Shore Gas and the EPA.

The document can be summarized as follows:

PROGRAM SUMMARY

BSI Environmental, Inc (BSI) conducted a study and prepared this report as an evaluation of the potential of a treatment train that includes mechanical water washing using the TERRALAVAR - Soil Washing process. It was prepared as a summary document to provide guidance information for evaluation of soil washing as a remedial option in the Waukegan MGP.

APPROACH

BSI collected samples of soil from the Waukegan MGP areas of known contamination as identified by previous work. The samples were collected to include soils with various levels of contamination. BSI shipped the soil samples to the environmental laboratory located in the Umweltschutz Nord Group Headquarters at Ganderkesee, Germany. The lab work demonstrated the effectiveness of the TERRALAVAR - Soil Washing on a Bench Scale.

CONCLUSIONS

Mechanical soil washing can reduce the concentrations of total petroleum hydrocarbons (TPH) in non-saturated soils at the Waukegan MGP to levels below expected regulatory goals.

Mechanical soil washing can meet the objectives of 1,000 mg/kg hydrocarbons and reduced toxicity provided contaminated soils treated are similar to those tested.

Contaminated soils with higher concentrations of hydrocarbons may require additional treatment.

Wash water from soil washing contains 1.5% to 2.8% of fines suspended during the washing process. Wash water can be treated with flocculents and pressed to remove fines as a filter cake. The treated water can either be reused in the washing process, discharged as waste to the municipal water treatment facility, or subjected to further treatment. The option selected for wash water will depend on - water supply, regulatory requirements and cost.

ESTIMATED SOIL REMEDIATION PROJECT COSTS

Non Tar Saturated Soils

Non-tar saturated soils, are suitable for soil washing. Based on the Bench Work performed, BSI estimates that the cost related to the implementation of a treatment train that includes mechanical water washing using the TERRALAVAR - Soil Washing process is estimated to between $50-$70 per cubic yard.

Tar Saturated Soils

Tar saturated soils, will require an alternate treatment technology. Based on the Bench Work performed, BSI estimates that the treatment cost for stabilization, if acceptable, with possible reuse for these materials, utilizing BSI proprietary technology to be between $60-$80 per cubic yard. The cost of off-site disposal was not evaluated by BSI at this time but remains an option for these materials.

RECOMMENDATIONS

BSI recommends proceeding with a field scale demonstration of soil washing technology immediately followed by full-scale treatment of the contaminated materials. This demonstration should treat 1,000 CY of contaminated soils. The plant is self-contained and can be situated adjacent to the Waukegan MGP or within the OMC North Plant. Excavation should be conducted during the fall during cooler temperatures to help facilitate the segregation of saturated and nonsaturated soils.

BSI VALUE PROPOSITION

- BSI is a member of the Umweltschutz Nord Group (UN) one of the Worlds Premier Environmental Remediation companies. UN was responsible for the Environmental Remediation of many US Military bases upon US Military departure from Germany, remediation of - Kuwaiti Oil Fields after Sadam Hussein set the oil fields on fire, and has an ongoing environmental remediation contract for the port of Bremen, Germany.

- UN has extensive successful experience in environmental remediation projects, similar in nature to the Waukegan Manufactured Gas Plant Site. A reference list of

MGP sites is attached. UN's technological experience at former MGP sites includes Soil Washing, Biotreatment and Thermal Treatement.

- BSI is housed in the TEC Development International Accelerator, the former OMC Environmental Building, which is in the center of the Waukegan Manufactured Gas Plant Site.

- BSI has on site management and staff to directly oversee and manage the Waukegan Manufactured Gas Plant Site Remediation.

- BSI is a member of the Waukegan economic community, employing not only internal staff but providing opportunities to multiple companies and sub contractors.

- BSI is a critical member of the OMC North Plant Redevelopment Project whose mission is to rehabilitate the plant and convert it into the epicenter for the environmental remediation of the contaminated soil and water of the Waukegan region.

- BSI guarantees its technology and products.

- BSI guarantees its time schedules.

- BSI guarantees it contracted costs.

We thank you for inviting us to participate in this endeavor, which has not only direct impacts on the City and Port of Waukegan but the entire Great Lakes region.

Sincerely,

Pat Faessler
President
BSI Environmental

4474 Woodbine Road
Pace, Florida 32571
Cell (850) 380 1036
Phone (850) 995 3280
Fax (850) 995 4019
Email faes3@msn.com

References
Recent (2001 –2002) Remediation of Former Manufactured Gas Plants Projects

Project	Volume	Remedial Technology	Contamination	Concentration	Contact
Mohrenstraß, Wuppertal, Germany	9,177 t	Thermal soil remediation TERRATHERM®	PAH	4,500 ppm -<10 ppm	AAE mbH, Herr Flach, Beim Industriehafen 39, 28237 Bremen, Germany, Tel.: +49 4 21-69 45 10
Weißenfelser Straße 17, Naumburg, Germany	23,000 t	TERRALAVAR®-soil washing,	TPH, PAH, Heavy Metals, Cyanide	TPH 6,920 mg/kg TS - TPH 1000 mg/kg TS, PAH 109 mg/kg TS -, PAK < 20 mg/kg TS,	ABU Coswig, Industriestr. 22, 06869 Coswig, Germany, Tel.: +49 3 49 03-51 00
Uferstraße, Kiel-Wik, Germany	68,300 t	TERRALAVAR®-soil washing, Thermal soil remediation TERRATHERM®, Biological soil remediation TERRAFERM®	TPH, PAH, BTEX, Phenol	PAH 20-5000 mg/kg TS - < 20 mg/kg TS	UMWELTSCHUTZ NORD, Mr van den Bongardt, Tankweg 2, 21129 Hamburg-Finkenwerder, Germany, Tel.: +49 40-31 97 71 40
Uferstraße, Kiel-Wik, Germany	11,000 t	TERRALAVAR®-soil washing, Thermal soil remediation TERRATHERM®, Biological soil remediation TERRAFERM®	PAH, BTEX, TPH, Phenol	PAH 20-5000 mg/kg TS - < 20 mg/kg TS	UMWELTSCHUTZ NORD, Mr van den Bongardt, Tankweg 2, 21129 Hamburg-Finkenwerder, Germany, Tel.: +49 40-31 97 71 40
Thiergarten-straße 12-14, Büdingen, Germany	3,800 t	Thermal soil remediation TERRATHERM®	PAH, Cyanide	PAH ~ 6000 mg/kg TS - < 20 mg/kg TS, Cyanide 1100 mg/kg TS - <100 mg/kg TS	AAE mbH, Herr Flach, Beim Industriehafen 39, 28237 Bremen, Germany, Tel.: +49 4 21-69 45 10
DURMIN GmbH, Bayreuth, Germany	11,571 t	Biological soil remediation TERRAFERM®	TPH	TPH 1,300 mg/kg TS - < 10 mg/kg TS PAH 321 mg/kgTS – 4 mg/kg TS	UMWELTSCHUTZ Zwickau, Mr Enke, Reinsdorferstr. 29, 08066 Zwickau, Germany, Tel.: +49 375-28 28 10
Thomas wang a/s Dänemark	6,000 t	Thermal soil remediation TERRATHERM®	PAH, TPH	TPH 7500 ppm - 500 ppm	AAE mbH, Mr Flach, Beim Industriehafen 39, 28237 Bremen, Germany, Tel.: +49 4 21-69 45 10

In summary, BSI - UMWELTSCHUTZ NORD has decontaminated 193,166 tons of soil in the course of remediating former Manufacured Gas Plants.

SOIL WASHING TO REDUCE THE TOXICITY OF CONTAMINATED SOILS AT THE WAUKEGAN MGP RESTORATION PROJECT

A BENCH TEST

July 16, 2003

INDEX

SOIL WASHING TO REDUCE THE TOXICITY OF CONTAMINATED SOILS AT THE WAUKEGAN MGP RESTORATION PROJECT

A BENCH TEST

Pat Faessler, MS*, Charles Bird PE* Gunter Tadje*, Dr. Andreas Klamka Hans-Peter Ratzke**,**

**BSI Environmental, Inc, ** Umweltschutz Nord,*

ABSTRACT

This report describes a treatability study for mechanical washing of Vadose Zone Soil Remedial Components (Soil Operable Unit). The subject soils are divided into three sub categories; the PAH Remediation Zone, the Arsenic Remediation Zone and the Marginal Zone. Other site areas are covered by Institutional Controls and a Soil Management Plan. This study focuses on treatment options for contaminated soils and debris which are located in the PAH Remediation and the Arsenic Remediation Zones. The soils were contaminated as a result of activities at the Former Waukegan Manufactured Gas and Coke Plant, formerly located on the site. The objective of this study is to identify technologies capable of economically reducing the contamination level of soils. The acceptable goal for soil to be left on site is for the concentration of the nine chemicals listed in Table 1, see Appendix F ("Preliminary Design the Soil Operable Unit Waukegan Manufactured Gas and Coke plant site Waukegan Illinois November 2002") ROD Soil Cleanup Levels to be below the Utility/construction RHE Levels. Soil samples were obtained by BSI Environmental, Inc. (BSI) staff from areas at the site identified by Conestoga Rovers & Associates. The soil samples were selected to represent the physical characteristics of site soils and the full range of contamination levels.

This test, conducted at the Umweltschutz Nord GmbH Group (UN) environmental treatability laboratory, has shown that washing may be appropriate for non tar saturated soils at the site. For these soils the washing process can reduce the PAH and arsenic concentrations to below the remediation goals. When washing is utilized the addition of a flocculent to the process will allow re-circulation of the wash water.

At the estimated full scale processing rate of 20-40 metric tons (Mg) per hour, use of water alone without re-circulation would require the supply and disposal of approximately 200 cubic meters of fresh water per hour (880 GPM). By using a flocculent, the contaminants and fines can be removed from the water for disposal as a sludge cake. Although this may also allow disposal of the cleaned wash water in the local sewer system, the water usage may be unnecessarily high. The separated water is clean enough to be reused for washing. By re-circulating the wash water, only the water that clings to the soil (approximately 15% moisture) and that lost to evaporation would need to be replaced. This make up water is estimated to be about 4 cubic meters per hour (approximately 20 GPM).

It is important to note that the flocculents (polyacrylamides like S2 or CHW No. 855 similar to PK 24) used in this test are similar to those used in drinking water treatment in which the residual content of monomers is restricted to <1%). It may be desired that even if the treatment water is to be wasted to the local sewer system that the flocculent be used to clarify the water.

INTRODUCTION

As a result of past activities including coal gasification and creosote treatment of timbers, the former Manufactured Gas Plant site in Waukegan - was impacted by the inadvertent release of petroleum hydrocarbons. As part of the Waukegan Manufactured Gas Plant Cleanup and Abatement Order issued by the EPA, Waukegan MGP must identify effective remedial methods. This study was undertaken to evaluate the effectiveness of soil washing technology.

As part of the remediation technology selection process at the Waukegan MGP facility, the sampled materials were tested for total PAH contaminants. This total number accurately reflects the contamination as listed individually in Table 1 of the investigation report compiled by Conestoga Rovers (Preliminary Design the Soil Operable Unit Waukegan Manufactured Gas and Coke plant site Waukegan Illinois November 2002). Visual and analytical analysis by experienced operators identified that some of the soils sampled were not candidates for soil washing technologies.

When the contaminants are found in pure layers or saturated soils washing is not possible. These materials must be separated during excavation and handled in an acceptable manner. This may include: mixing with fixing additives if necessary, and sending to an appropriate disposal facility such as a landfill or used as fuel at an approved facility.

It is suggested for the remaining material, soil washing using limited amounts of chemical agents would produce a washed soil with acceptable residual contaminant levels. Soil washing has been applied to other sites where similar remediation goals were achieved. A list of these sites is attached under separate cover. When soil washing has been selected, only the cleaned sand and gravel, which meets the remediation goals, is returned to the excavation sites.

If soil washing is selected, contaminated soils surrounding the pure tar layers would be processed in a treatment train that includes screening and washing. In this process contaminated soil would separated into cleaned soil and a contaminant concentrate. The contaminants, together with the clay and silt fraction would be separated and sent to an authorized disposal facility. The cleaned soil could be returned to the excavation.

To investigate this theory the Waukegan MGP parties authorized BSI Environmental, Inc. to conduct a soil treatment investigation. This investigation included provisions to collect samples and conduct a series of wash tests to develop specific data that would indicate if further consideration would be prudent. The details of this can be found in the APPROACH section of this document.

TERRALAVAR - SOIL WASHING METHOD

PROGRAM SUMMARY

BSI Environmental, Inc (BSI) conducted a study and prepared this report as an evaluation of the potential of a treatment train that included mechanical water washing using the TERRALAVAR - Soil Washing process. The results of the study are contained in this document. It was prepared as a summary document to provide guidance information to evaluate the inclusion of soil washing as an option in the Waukegan MGP Remediation Investigation Study. This report was not prepared as a technical guidance document or operations work plan. The information in this document is proprietary and intended to be used only by Waukegan MGP to evaluate soil-washing technology for the Waukegan MGP Restoration Project.

APPROACH

BSI staff collected 10 bulk samples of soil, during two sampling events, from the Waukegan MGP areas of known contamination, as identified by previous work. The samples were collected to include soils with various levels of contamination. BSI shipped the soil samples to the environmental laboratory located in the Umweltschutz Nord Group Headquarters at Ganderkesee, Germany.

- To help demonstrate the effectiveness of the technology BSI Environmental, Inc. (BSI) conducted the following Bench Scale Soil Washing Studies. A copy of this data can be found in the Appendices

TEST AND OBSERVATIONS

Washing Process Description

Procedure: (* refer to the flow chart)

Step 1*: Upon receipt of the buckets of material from Waukegan MGP the buckets were opened and the sand was mixed to homogenize it. This was done prior to making observations or removing any material for bench testing.

Step 2: Two representative samples of the homogenized material were removed for the wash testing. One sample is considered the primary sample and the second a control. The control was subjected to parallel tests and selected analysis to insure the quality of the primary results. Sub-samples of each sample were analyzed for hydrocarbons. The results are reported as TPH and TCH using standard laboratory protocols VD01 and VD03. The results are posted below.

Step 3: Each test run followed the VD01 protocol. They begin by placing 1000 grams of the contaminated sand in a powered Hobart mixing bowl.

Step 4: Setting the mixer on speed #1 approximately 50-150 ml of either fresh water or recirculated flock-free wash water are added from a previously filled 500ml graduated cylinder. This initial water is added until the mixture is brought to the consistency of a smooth paste. At this point the Tensid (surfactant) was added to those tests that included surfactant. For this

purpose, a syringe was filled with a 4% Tensid solution and weighed. Approximately 1-6 grams of the Tensid solution was added while stirring (record the amount on the wash protocol). The Tensid solution was added at a rate of 4g of solution per kg of soil. After adding the water, or the water and surfactant solution, the mixing speed is increased to Speed #2 and mixed for approximately 5 minutes. During the process, notes are taken periodically on the conditions.

Step 5: Next the speed is reduced to #1 and the remaining water in the 500-ml beaker is added and the mixture becomes an homogeneous slurry.

Step 6; Next the power is turned off and the soil is allowed to settle for at least 10 minutes. The free liquid above the soil, together with suspended contaminants and fines is decanted into a 3-liter flask. Next 250 ml of water is added, stirred thoroughly, and let to stand, then again decanted into the flask. This process is repeated five times until a total of 2,000 ml of wastewater has been obtained. This entire washing process can be carried out with flock-free wash water.

Step 7: The wash water is set aside for flocculation tests.

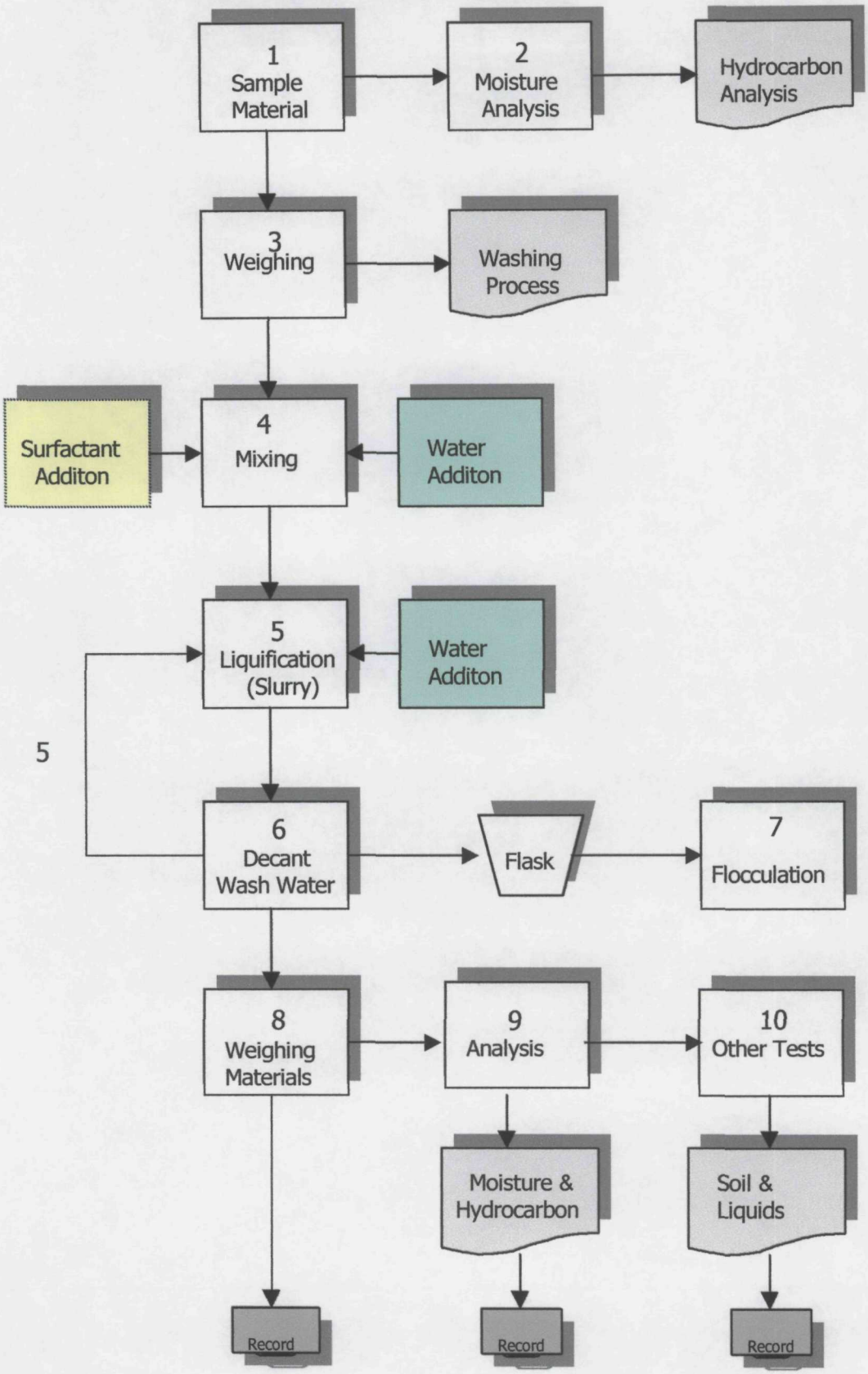
Step 8: The washed sand is placed in a large porcelain bowl (previously tare weighed). The water is removed by tapping, tipping and decanting. After all of the free water has been removed the damp soil is weighed and recorded. The soils were also dried to determine the amount of water retained by the damp soil.

Step 9: The washed soil was analyzed for hydrocarbon and moisture content. Results were noted as required by protocol VD03, "Hydrocarbon and Moisture Determination." In addition a density separation was conducted. In this procedure the lighter material is withdrawn using a heavy media. This procedure simulates the spiral classifiers that can be used in the wash process in order to reduce the hydrocarbon value. The results of this step are noted in the Wash Test Results in the following sections.

Step 10: Other tests required for the bench-test are conducted on the soil fractions and liquids.

* The 10 points correspond with the points in the flow chart.

Soil Washing Test, Flow



Flocculation Process Description

General Procedure:

The wash water from the washing process was mixed and poured into a 200ml beaker. A volume of 0.2 ml of primary flocculating agent was added to a second beaker. The contents of the two beakers were then poured back and forth five times. Next, in increments of 0.1ml, more flocculent was added and the beakers were poured back and forth until light particle structures formed (micro-flocks) and the quantity was determined ("Flocculation Process," VD02).

Next, the preliminarily flocculated suspension was treated with the secondary flocculation agent in the same manner as above, using 1.0 ml initially and increments of 0.5 ml until large flocks formed and settled easily, and the clear phase becomes evident. The amounts of materials were recorded and formation of the flocculation and clear phase was documented. The chemical usage rates cannot be transferred directly to large-scale operations for numerous reasons, representativeness of the sample, use of fresh vs. recycled water, other mixing and dosing peculiarities, etc.

An alternative flocculent was also tested. The flocculation agent is identified as universal flocculating agent (PK24). For this test, 4 to 8 ml of flocculating agent was added to the wash water.

The laboratory wash water was evaluated for pH and conductivity, and the values were recorded.

A 10% solution of the primary flocculent was used at a rate of 0.3 ml / 200 ml of sludge. This equates to a consumption of 300 g/Mg (metric ton) of soil. This might be reduced in the plant because it is difficult to meet the point of coagulation in the lab scale.

A 1% solution of the secondary flocculent was used at a rate of 1.0 ml / 200 ml sludge. This equates to 10 g/Mg (metric ton) of soil.

The universal flocculent was mixed to a 0.1% solution and used at the rate of 80 ml / 200 ml of sludge. This equals a consumption of 80 g/Mg (metric ton) of soil.

Note, the consumption value cannot be precisely transferred to operation values because of numerous differences in the fresh water vs. recirculated water. It is also noted that the water analysis from Waukegan MGP, describes water suitable for washing however, the water qualities may have some effect on the amount of flocculent required.

Preparation of the Solutions used in the lab tests:

Primary coagulant (10%)	A 250ml covered beaker with a magnetic mixer was tare weighed; Then add 10 grams of CFL245, ABU flock P1, and add 100 grams of water to the beaker. After short agitation, the solution is ready.
Secondary (0.1%)	Into a 250ml covered beaker, put 200 grams of warm water and stir thoroughly.

Universal-Flocculent	Measure and add 0.2 grams of polymer (AN 234, ABU flock S2) gradually while stirring the water. After complete absorption and development (about 45 minutes), the mixture is ready.
Tensid (5%)	Into a 250ml covered beaker, put 95 grams of water and stir. Weigh out 5 grams of Tensid (Terra-/ABU-clean 0602) and dribble it into the water while stirring. When the Tensid is completely dissolved, the mixture is ready to use.

The solutions are subject to degradation (Tensid) and transformation (polymer) reactions, and therefore cannot be stored indefinitely. It is best to use them within one week of preparation.

Density separation:

A density separation test is performed on samples subjected to mechanical washing with and without chemicals. Density separation was added to the testing protocol to improve removal efficiencies. This technique may be required if higher concentrations of hydrocarbons are encountered.

In the plant, density separation is performed on spiral separators. The principle is similar to a gold washing pan. It is a physical process completely without chemicals. To simulate this in the lab a density separation solution is used. This is a cold saturated zinc chloride solution with a density of approximately 2 kg/l. Because of proton donation from the hydration it is an acid. The washed soil is mixed with the solution, after settling of the heavy particles the suspended light particles are taken away.

Process Description:

In a 500 or 1000 ml measuring beaker, place 150 or 300 grams of the washed soil respectively, then fill the beaker with the density separation solution and shake until the material is fully suspended. Let it sit for an hour, skim off the floating material, then shake again to suspend the material in the solution, and let stand. Remove the floating material again, preferably on the following day. Then pour off (and store) the suspension fluid and thoroughly rinse the soil.

Preparation of the density solution:

Tare weigh a 2,000ml beaker with a magnetic stirrer inside and add 750 grams of warm water; then add small doses of zinc chloride until the solution reaches a density of 2 kilograms per liter (It may be necessary to heat it lightly). It will require about 2.4 kilograms of zinc chloride, yielding 1.6 liters. Pour the used solution through a 0.038ml sieve. It is better to filter it; however, the viscosity of the solution may clog the filter paper. If necessary, use more zinc chloride solution to wash it out.

Soil Wash Test Results, BSI Waukegan MGP

Laboratory Report
Alphacon

Project: BSI Soil Washing Waukegan **Report Number: 0300202**

Client: Umweltschutz Nord GmbH GCIC

Characterization of the samples:

Date of entry:	6/4/03	Sampling site:	Manufactured Gas Plant
Sampling date:	5/20/03	Location:	Waukegan Illinois USA
Sampler:	BSI		
Delivery service:	TNT		

Sample identification:	Number of sample:	type of sample:
Sample 1, E of TT00C, 0-150mm	00530	solid material
Sample 2, TP 149, 0-150mm	00531	solid material
Sample 3, Surface Bloom, 3m E of 1	00532	solid material
Sample 4, TT 19 W N.End 3 ME, 0-150mm	00533	solid material
Sample 5, TP 117, N.End	00534	solid material
Sample 6, In TP 123	00535	solid material
Sample 6, TP 123 after soil washing	01013	solid material

Results of Analysis

		Sample 1 E of TT00C-150mm	Sample 2 TP 149, 0-150mm	Sample 3 Surface Bloom, 3m E of 1	Sample 4 TT 19 W N.End 3 ME, 0-150mm	Sample 5 TP II7 T, N.End	Sample 6 In TP 123	Sample 6 In TP 123 after soil washing
Parameter and examination procedure	Unit	00530	00531	00532	00533	00534	00535	01013
Dry substance of the soil according to DIN ISO 11465	%	84.7	84.5	84.6	90.0	87.0	89.9	67.3
Acid Extraction with $HCl+HNO_3$ (1+3)) according to DIN ISO 11466	-	x	x	x	x	X	x	x
Arsenic, ICP according to DIN EN ISO 11885-E 22	mg/kg TS	< 20	95	< 20	< 20	< 20	< 20	< 20
16 PAH (Poly Aromatic Hydrocarbons) according fo EPA 610 using GC-MS								
Naphthalene	mg/kg TS	360	10,000	19,000	1,900	1,500	92	0.38
Acenaphthylene	mg/kg TS	91	1,700	3,300	90	55	20	0.26
Acenaphthene	mg/kg TS	50	340	470	290	270	20	3.9
Fluorene	mg/kg TS	260	2,600	4,800	3,500	3,900	40	4
Phenanthrene	mg/kg TS	770	6,200	13,000	12,000	14,000	86	31
Anthracene	mg/kg TS	210	2,000	3,700	1,900	2,200	36	4.7
Fluoranthene	mg/kg TS	690	3,800	7,900	6,900	7,500	88	36
Pyrene	mg/kg TS	510	2,700	5,500	4,800	5,300	77	24
Benz(*a*)anthracene	mg/kg TS	290	1,700	3,200	2,700	2,800	64	11
Chrysene	mg/kg TS	260	1,600	3,000	2,800	2,700	65	13
Benzo(*b*)fluoranthene	mg/kg TS	280	1,600	3,000	2,500	2,500	64	16
Benzo(*k*)fluoranthene	mg/kg TS	130	710	1,400	950	730	36	5.6
Benzo(*a*)pyrene	mg/kg TS	210	1,300	2,300	1,800	1,600	50	11
Indeno(1.2.3-*cd*)pyrene	mg/kg TS	130	940	1,600	890	970	48	8
Dibenz(*ah*)anthracene	mg/kg TS	81	450	550	370	290	37	2.6
Benzo(*ghi*)perylene	mg/kg TS	120	700	1,100	750	600	36	7.8
Total PAH	**mg/kg TS**	**4,400**	**38,000**	**74,000**	**44,000**	**47,000**	**860**	**180**

x: determining limit increased due to matrix effects

RESULTS

- Washable soils demonstrated a laboratory removal efficiency of 81% going from 860 mg/kg to 160 mg/kg PAH.
- Higher removal efficiencies are expected in the field.
- Typical soils suitable for washing at the Waukegan MGP site have a grain analysis with roughly 80% greater than 0.063 mm
- Maximum PAH concentration suitable for washing is approximately 10,000 mg/kg
- Arsenic is associated with silt and fine materials and will be separated form the site soils and concentrated in the filter cake.

Table of Scale-up Data

Water Consumption		Cubic Meters per Hour	Cubic Meters per ton
Closed System Using chemical flocculent and filter press		4-8	0.1-0.2
Open System No reuse of water		150 - 200	3 - 4
Area Requirements (Approximate)	Length 20 meters	Width 40 meters	Height 9 meters
Power Requirements			
Demonstration	300 kW Generator		
Full Scale	Hard Power Line Voltage and Amperage to be determined		
Chemical Requirements		Usage g / Mg (grams per metric ton)	% Recovery Or loss
Surfactant (Tensid)		20-40	35 PPM in washed soil
Flocculent a. (primary + secondary)		310	>99% in residue
Flocculent b. (universal Flocculent)		80	>99% in residue
Washed Soil	% Moisture	PAH	
	15	< 1,000 mg/kg	

CONCLUSIONS

Mechanical soil washing can reduce the concentrations of hydrocarbons (THC and TPH) in WaukeganMGP sands to levels below expected regulatory goals.

Wash water from soil washing typically contains 1.5% to 2.8% of fines suspended during the washing process. Wash water can be either disposed in the local sewer or treated with flocculents and recycled in the washing process. Suspended solids removed would be filtered to remove fines as a filter cake.

Mechanical soil washing with chemicals can meet the objective of 1,000 mg/kg hydrocarbons provided they are similar to those tested. Sands with higher concentrations of hydrocarbons may require additional treatment such as density separation or density separation with chemicals.

RECOMMENDATIONS

BSI recommends proceeding with a field scale demonstration of soil washing technology. This demonstration should treat at least 1,000 CY of contaminated soils. The wash plant is self-contained and can be situated on or near the contaminated site. Initially the plant should be configured to operate without the density separation process but the equipment should be available on site. Washing should be conducted with surfactants. The use of flocculent will depend on desired processing of wash water after washing.

BIBLIOGRAPHY AND REFERENCES CITED

Preliminary Design of the Soil Operable Unit Waukegan Manufactured Gas and Coke plant site Waukegan Illinois November 2002 Conestoga Rovers

Appendix A

Site: Manufactured Gas Plant
***Location:* Waukegan Illinois USA**
Environmental Samples,

			2003Jun12 U-Nord	2003Jun12 U-Nord	2003Jun12 U-Nord	GPS	GPS
Number.	Date Sampled	Description	PAH	As	Dry Substance	North	West
			mg/kg	mg/kg	%		
1	2003May20	1 m East of TT00C, removed sod and dug 0 – 15 cm	4,400	< 20	84.7	42□ 21.990'	87□ 49.096'
2	2003May20	Center of TP 149. removed crust then dug 0 - 15 cm	38,000	95	84.5	42□ 21.992'	87□ 49.094'
3	2003May20	3 meters east of #1 at surface bloom. Surface warmed by the sun was soft flowing, material was easy to dig, granular glistening.	74,000	< 20	84.6	42□ 21.991'	87□ 49.092'
4	2003May20	3 m east of TT 19 W @ North end, sampled Surface bloom, warmed by sun, tar was tough and plastic, dug sod and all to 15 cm then hit layer of frozen tar.	44,000	< 20	90	42□ 21.899'	87□ 49.100'
5	2003May20	In TP 117, Sampled spoil 2 m South of N end, Visible tar in trench fill	47,000	< 20	87	42□ 21.890'	87□ 49.093'
6	2003May20	In TP 123, 12 m North of South end, Surface, spoil including tar and black sand 0 - 20 cm	860	< 20	89.9	42□ 21.910'	87□ 49.115'
SB 201	2003April29	Previous	Not analyzed	Not analyzed		42□ 21.982'	87□ 49.072'
SB 40-02	2003April29	Previous	77.0	23.0		42□ 21.927'	87□ 49.104'
TP 107	2003April29	Previous	3.1	110		42□ 22.037'	87□ 49.057'
TP 144	2003April29	Previous	29.0	1400		42□ 21.959'	87□ 49.077'

Samples 1 – 6 taken and located on 2003May20, the samples taken on 2003April19 were GPS located on 2003May20.

Appendix B

'Second' Wash Test, BSI July, 2003

Alphacon GmbH conducted a test to evaluate the possibilities of soil washing for a project in the U.S., this test was conducted after receiving six samples (see Appendix A). Organoleptic testing has shown that there were large quantities of tar, respectively heavy oil-like high viscous agglomerates, in five of six samples.

The samples were analyzed to confirm the presence of the stated toxin parameters PAH and arsenic. The tests confirmed the presence of PAH with the main toxic potential is in samples 1-5 which also contained the tar agglomerates. The results of these tests are shown below:

Declaration analytic PAH (EPA 610 via GC-MC)

Sample 1: 4.400 mg/kg
Sample 2: 38.000 mg/kg
Sample 3: 74.000 mg/kg
Sample 4: 44.000 mg/kg
Sample 5: 47.000 mg/kg
Sample 6: 860 mg/kg

Discussion Results of Samples 1 through 5

At first glance it seems theoretically possible to remove the main toxic potential from the soil by separating the toxic agglomerates. However, these toxic agglomerates are binding large quantities of the soil (sand) because of its viscous gluey properties. This binding process is even enforced by a wet mechanical opening procedure. Just because of a simple stirring process, constantly enlarging balls are created out of a mixture of toxin and sand. An effective separation by means of a wet mechanical process of saturated soils does not appear to be possible.

The following points mitigate against a wet mechanical preparation of the materials.

- A large part of the soil mass is bound because of the high viscosity of the toxic agglomerates (poor efficiency of separation).
- A separation of the toxins from the soil granule seems hardly possible by using kinetic energy and surfactants (viscosity).

- Because of the presence of large quantities of tar, a wet mechanical treatment will tend to create agglomerates of tar and soil, sand etc that would travel with the larger cleaned soil particles.

Discussion Results of Sample 6

A laboratory washing test has been done with the material of Sample 6. The test examined the possibility that the contamination can be transferred into a water phase by means of washing of the soil matrix.

Procedure: See operation instructions, "Laboratory Washing Test"

In this laboratory wash test a cleaning from 860 mg/kg PAH to 180 mg/kg PAH occurred. It has to be mentioned that in laboratory tests not all large technical processes can be simulated sufficiently, specifically for the energy entrance in the opening up process of the material. Soil washing plants are showing a better cleaning than is possible in a laboratory washing test. We are concluding that, in case of use of a soil washing plant, the residual toxic substances can clearly be smaller than 100 mg/kg PAH.

In case of establishing a soil washing plant, it is important to consider what equipment combinations can be used including for example;

- Log washers
- Circulating separators
- Rising current classifiers
- Attrition mills or trommels
- Fine material separation equipment

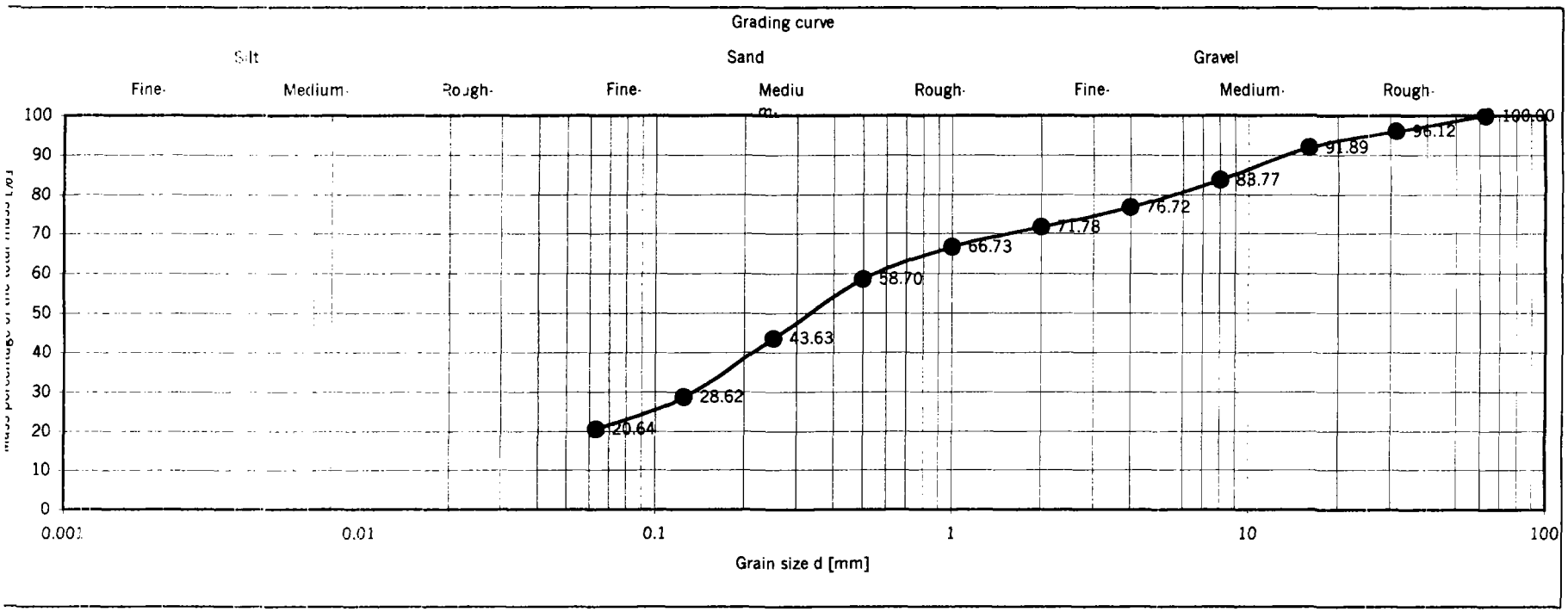
It is advisable that BSI works with the special departments in Umweltschutz Nord and ABU regarding the evaluation of the washing tests. Eventually other soil homogenization and separation processes for the soil washing treatment train can be offered. Before you start it is advisable to clarify which combination to use that will make the best sense.

We also established a granule curve of Sample 6. This curve indicates that that 20% of the sample is smaller than 0.063 mm. Base on experience, approximately 20% of the original soil processed in a successful soil washing program will be residual contaminants that have to be eliminated.

Particle size [mm]	Total amount [%]	Scale pan empty [g]	Scale pan with sample [g]	Wet mass [g]	Dry substance [%]	Dry mass [g]	Mass [g]	Mass percentage [%]
0.063	**20.64**	272.33	498.52	3150.25	89.9	2832.07	226.19	7.99
0.125	**28.62**	282.35	707.42	3150.25	89.9	2832.07	425.07	15.01
0.25	**43.63**	295.43	722.23	3150.25	89.9	2832.07	426.8	15.07
0.5	**58.70**	301.89	529.30	3150.25	89.9	2832.07	227.41	8.03
1	**66.73**	311.39	454.21	3150.25	89.9	2832.07	142.82	5.04
2	**71.78**	349.43	489.40	3150.25	89.9	2832.07	139.97	4.94
4	**76.72**	352.52	552.34	3150.25	89.9	2832.07	199.82	7.06
8	**83.77**	391.45	621.35	3150.25	89.9	2832.07	229.9	8.12
16	**91.89**	401.55	521.34	3150.25	89.9	2832.07	119.79	4.23
31.5	**96.12**	442.52	552.38	3150.25	89.9	2832.07	109.86	3.88
63	**100.00**	445.72	445.72	3150.25	89.9	2832.07		

Suchzeile Header
Sample No.: 000535
Sample identification: Sample 6, IN TP 123
Sampling site: Manufactured Gas Plant
Location: Waukegan Illinois USA
Sampling Date: 5/20/03
Employee: EF

BSI - Umweltschutz Nord
Gradation Curve Chart



0005:35
Sample 6, IN TP 123
Manufactured Gas Plant
Waukegan Illinois USA
5/20/03
7/1/03
EF

Screening method: Wet screening

The percentage of silt < 0,063 mm amounts 20.6 %

- Also, even by using mechanical energy and surfactants (detergents), a separation of the pollutant from the sand fraction is hardly possible.
- Based on the high frequency of polluted agglomerates, some of the tar will adhere to the larger soil particles and not be removed in a wet mechanical treatment.

For further understanding, we are describing again the basics of soil washing as follows:

Basics of Soil Washing

By using a soil washing process, soils and soil-like materials, which are polluted with organic and inorganic pollutants, for instance, mineral oil and/or heavy metals, can be cleaned. The principle of soil washing is based on the fact that by using water with the addition of motion energy (friction) and, if necessary, with the addition of suitable biologically degradable cleaning agents, the pollutants can be separated from the soil particles in one separation step. The pollutant can then be suspended and separated with the fine soil fraction from the heaver coarse sand and gravel particles by using process water. In that way it (the pollutant) is separated with the clay and silt fraction of the soil in a more concentrated form and expelled from the system as press cake.

The cleaned material is separated afterwards from the washing water according to its particle size by using sieves of different mesh sizes. If necessary, light materials are separated from the material by means of sorting jigs. Generally, light materials combine with the contaminations based on their large inner surfaces (coal, wood, slag), similar to active carbon. Because the contaminants are bound within the light materials they cannot be washed out, therefore the light materials are separated as waste.

The cleaned material is generally considered for reuse as backfill and in some cases building material for streets and roads or for asphalt mixing plants.

The wash water containing contaminants and the finest soil particles is cleaned in the water processing stage. Here organic flocculants are used, to clump the fine particles of soil and pollutants into groups or "flocks". The larger flocks are then separated from the wash water in a filtration process. The resulting filtered solids are pressed to remove most of the water. The resulting filter cake has a water content of around 35% and can be easily handled for reuse or disposal. By this cleaning step the wash water is generally sufficiently purified and can be reused into the cycle of the washing process. If necessary, activated carbon and/or bentonite can be added as additional absorbents in additional water process steps. In this manner the plant does not create any polluted wastewater.

Appendix C

First wash test on the sampled materials
Alphacon GmbH analysis report on samples taken from the Former Waukegan Manufactured Gas and Coke Plant Site, Operable Unit 2 of the Outboard Marine Corporation Superfund Site.
June 10, 2003 Translation by G. Tadje and C. Bird

Wash Test "BSI"

For the evaluation to check the possibility of soil washing for a project in the United States, Alphacon GmbH has received six samples. After organoleptic testing, it became evident that in five of the six samples contain major quantities of tar, respectively, heavy oil-like, high viscous agglomerates.

The executed declaration analytic with regard to the pollutant parameters PAH and arsenic confirmed the supposition that the main polluting potential is in the detected agglomerates. Sample No. 6 was, as received, below remediation targets. Visible pollutant agglomerates could not be recognized in this sample. It was included in the sample group to represent a dominant soil type found at the site.

Declaration analytic PAH (EPA 610 by means of GC-MS):

Please see the sample results which are self-explanatory.

By separation of the pollutant agglomerates, it seems at first view theoretically possible to remove the main pollutant potential out of the soil. Based on the viscous gluey properties, these pollutant agglomerates, however, are binding substantial quantities of the soil (sand). This process is even increased by a wet mechanical separation process. Even by using a simple stirring process, steadily increasing balls are formed out of a mixture of pollutant and sand. An effective separation by means of a wet mechanical process does not seem to be possible.

The following points advise against a wet mechanical preparation of the materials:

- The high viscous properties of the pollutant agglomerates or binds the soil

Appendix D

Laboratory Report Alphacon

Project: BSI Soil Washing Waukegan **Report Number: 0300042**

Client: Umweltschutz Nord GmbH GCIC

Characterization of the samples:

Date of entry:	5/13/03	Sampling site:	Manufactured Gas Plant
Sampling date:	4/29/03	Location:	Waukegan Illinois USA
Sampler:	BSI		
Delivery service:	FedEx		

Sample identification:	Number of sample:	type of sample:
TP 107	00153	solid material
TP 144	00154	solid material
SB 40-02	00155	solid material
Composite sample of TP 107, TP 177 and SB 40-20	00156	solid material

Results of Analysis

		TP 107	TP 144	SB 40-02	Composite sample of TP 107, TP 177 and SB 40-20
Parameter and examination procedure	Unit	00153	00154	00155	00156
Dry substance of the soil according to DIN ISO 11465	%	86.9	90.1	88.9	88.5
Acid Extraction HCl+HNO_3 (1+3)) according to DIN ISO 11466	-	x	x	x	x
Arsenic, ICP according to DIN EN ISO 11885-E 22	mg/kg TS	110	1400	23	180
16 PAH (Poly Aromatic Hydrocarbons) according fo EPA 610 using GC-MS					
Naphthalene	mg/kg TS	0.26	< 0,05	0.13	0.12
Acenaphthylene	mg/kg TS	0.06	0.55	1.3	1.0
Acenaphthene	mg/kg TS	< 0,05	< 0,05	0.06	0.06
Fluorene	mg/kg TS	0.07	0.29	0.11	0.25
Phenanthrene	mg/kg TS	0.37	0.49	0.21	0.41
Anthracene	mg/kg TS	0.18	0.94	1.4	1.8
Fluoranthen	mg/kg TS	0.49	2.9	1.0	3.7
Pyrenee	mg/kg TS	0.27	0.12	0.25	0.30
Benz(*a*)anthracene	mg/kg TS	0.28	3.7	8.0	7.0
Chrysene	mg/kg TS	0.49	4.3	10	9.3
Benzo(*b*)fluoranthene	mg/kg TS	0.29	5.4	17	13
Benzo(*k*)fluoranthene	mg/kg TS	0.11	1.9	6.0	4.0
Benzo(*a*)pyrene	mg/kg TS	0.14	3.1	11	8.0
Indeno(1,2,3-cd)pyrene	mg/kg TS	0.07	2.5	9.4	5.5
Dibenz(*ah*)anthracene	mg/kg TS	< 0,05	0.78	3.0	1.8
Benzo(*ghi*)perylene	mg/kg TS	0.06	2.3	7.7	5.1
Total PAH	**mg/kg TS**	**3.1**	**29**	**77**	**61**

x: determining limit increased due to matrix effects

Appendix E

Laboratory Report Alphacon

Project: BSI Attempt of Soil Washing Waukegan **Report Number: 0300091**

Client: Umweltschutz Nord GmbH GCIC

Characterization of the samples:

Date of entry:	5/19/03	Sampling site:	Manufactured Gas Plant
Sampling date:	4/29/03	Location:	Waukegan Illinois USA
Sampler:	BSI		
Delivery service:	FedEx		

Sample identification:	Number of sample:	type of sample:
SB 201	00272	solid material

Results of Analysis

		SB 201
Parameter and examination procedure	Unit	
Acid Extraction A39with HCl+HNO_3 (1+3)) according to DIN ISO 11466	-	x
Arsenic, ICP according to DIN EN ISO 11885-E 22	mg/kg TS	170
16 PAH (Poly Aromatic Hydrocarbons) according fo EPA 610 using GC-MS		
Naphthalen	mg/kg TS	3.0
Acenaphthylene	mg/kg TS	0.25
Acenaphthene	mg/kg TS	< 0,05
Fluorene	mg/kg TS	0.46
Phenanthrene	mg/kg TS	2.9
Anthracene	mg/kg TS	0.64
Fluoranthene	mg/kg TS	3.6
Pyrene	mg/kg TS	2.7
Benz(*a*)anthracene	mg/kg TS	2.2
Chrysene	mg/kg TS	2.4
Benzo(*b*)fluoranthene	mg/kg TS	3.2
Benzo(*k*)fluoranthene	mg/kg TS	1.0
Benzo(*a*)pyrene	mg/kg TS	1.7
Indeno(1,2,3-cd)pyrene	mg/kg TS	1.4
Dibenz(*ah*)anthracene	mg/kg TS	0.58
Benzo(*ghi*)perylene	mg/kg TS	1.2
Total PAH	**mg/kg TS**	**27**

x: determining limit increased due to matrix effects

Table 1

ROD Soil Cleanup Levels
Waukegan Manufactured Gas and Coke Plant Site
Waukegan, Illinois

Chemical	Commercial/Industrial RHE[1] mg/kg[2]	Utility/Construction RHE mg/kg
Arsenic	2,050	940
Benzo(a)anthracene	1,500	1,160
Benzo(a)pyrene	150	116
Benzo(b)fluoranthene	1,500	1,160
Dibenzo(a,h)anthracene	150	116
Indeno(1,2,3-cd)pyrene	1,500	1,160
Dibenzofuran	NA	5,390
4-Methylphenol	NA	6,738
Napthalene	NA	48,556

[1] RHE - Representative high exposure
[2] mg/kg - milligram per kilogram